

# TS-960 SERIES

PRELIMINARY  
MARVIN TEST  
SOLUTIONS  
DATASHEET

## PXI SEMICONDUCTOR TEST SYSTEM WITH TIMING PER PIN DIGITAL SUBSYSTEM

- PXI-based integrated semiconductor test platform
- 20 slot 3U PXI chassis offers up to 512, digital I/O channels with PMU and timing per pin capability
- Application ready system offers a cost effective solution for digital and mixed-signal test applications
- Includes ICEasy test software tools - simplifying test creation and device characterization
- Bench top and integrated manipulator configurations



## DESCRIPTION

The GENASYS Semi TS-960 PXI Semiconductor Test System is an integrated test platform that offers comparable system features and capabilities found in proprietary ATE systems. Available as a bench top system or with an integrated manipulator, the TS-960 takes full advantage of the PXI architecture to achieve a cost-effective and full-featured test solution for device, SoC and SiP test applications. The test system incorporates a high power (60 watts per slot) PXI chassis and a custom-designed, performance test interface that supports the use of PCB DUT (Device Under Test) boards - a proven and high-performance method for interfacing to the device under test. Additionally, the receiver interface's pin blocks are field configurable, allowing users to upgrade the receiver when they modify or upgrade the system for new applications. The configuration of the receiver can support up to 512 dynamic digital channels, as well as a range of analog, device power supply (DPS) and RF resources.

The basic system includes 64, digital I/O channels; 64 static digital I/O channels; a programmable DPS; a system self-test and fixture; software for digital waveform editing / display; ICEasy - device test development tools; and Marvin Test Solutions' ATEasy software which provides an integrated and complete test executive and test development environment, allowing users to quickly develop and easily maintain test applications. With an additional 14 PXI slots available for adding more digital or analog test resources as needed, the TS-960 is the ideal test solution for semiconductor OEMs, fabless semiconductor vendors, incoming inspection / counterfeit detection labs and packaging / test vendors needing a cost-effective, open architecture, configurable test system.

For production test applications requiring integration with an automated handler, the TS-960 is available with the Reid - Ashman OM1069 manipulator which provides precise positioning of the test head and the flexibility to interface to automated probes and device handlers. The manipulator's spring loaded design allows for easy alignment and docking to handlers - eliminating the need for a complex receiver interface. The TS-960 features a handler compatible slide receiver, which offers the flexibility to interface to virtually any device handler.

## FEATURES

The base TS-960 platform uses the advanced GX5296 - a 3U PXI, 32 channel 125 MHz digital I/O card featuring timing and PMU per pin capability with sub-nanosecond edge placement resolution. A wide range of digital and analog instrument test options can easily be incorporated into the TS-960, offering users a compact test system that can support both functional and DC parametric test capabilities. And with the incorporation of an integral, modular test interface, the TS-960 offers users an application ready test system which can be upgraded or reconfigured in the field if needed. The system is also supplied with various software development and digital vector conversion tools, including support for ASCII, WGL, STIL, VCD/eVCD and ATP vector formats.

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## TS-960 CORE SYSTEM CONFIGURATION

The basic TS-960 core system includes the following test resources and capabilities:

- 20-slot, high-power PXI chassis with integral receiver interface
- Embedded Core 2 Duo controller with Windows 7
- 64 125 MHz digital channels with per pin PMU and per pin timing (expandable to 512)
- 64 static digital channels (expandable to 128), which can be used for fixture ID, UUT static control or DUT board relay control
- Programmable 0 to 48 V DPS (expandable to multiple channels)
- System self-test fixture and test program
- ATEasy test executive and programming environment
- Advanced digital waveform editing and display tool
- ICEasy test software development tools

## RECEIVER INTERFACE

The TS-960 platform employs a modular, pogo-pin style receiver interface which consists of various pin blocks and is field re-configurable. Interfacing to the device under test (DUT) is done via a device specific PCB which mates to the pogo pin interface and is held in position with an integral stiffener / hold-down assembly. The hold down assembly employs a slide receiver mechanism which facilitates interfacing to handlers.

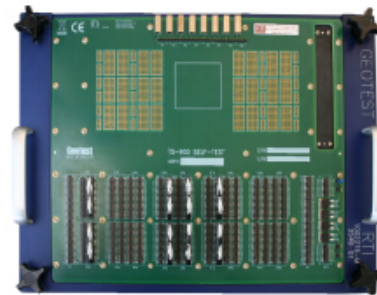
For digital interfacing, the receiver employs dual, 68-pin block assemblies which connect directly to the TS-960's PXI digital instrument resources, providing a high performance, controlled impedance interface. For user power connections, a power block is available which supports up to (4) user power suppliers and for general purpose analog and switching applications, a 78 pin block assembly with mating D-sub connector is available. RF and coaxial connections can be accommodated via an 8 connector, SMA block or blind-mate RF connector blocks. All receiver block positions are interchangeable, offering a high degree of flexibility.



TS-960 Receiver Interface

## SYSTEM SELF-TEST

The TS-960 is supplied with a system self test which includes an interactive self-test software procedure as well as a self-test PCB which interfaces to the receiver. The self-test is an ATEasy based test program and verifies functional integrity of the system and resource connections to the test system interface.



TS-960 Self Test Fixture

## SOFTWARE

The TS-960 is supplied with ATEasy, Marvin Test Solutions' test development and test executive software suite; digital waveform tools for developing, debugging and importing digital test vectors; ICEasy - a library of device test development tools; and all necessary instrument drivers which are compatible with variety of application development environments including ATEasy, LabWindows, LabVIEW, Microsoft Visual Studio languages and more.

The TS-960 ATEasy work space is provided with a pre-configured ATEasy System file and associated instrument drivers.

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It also provides access to DIOEasy and ICEasy tools, which provide the following capabilities:

- Pin and pin group mapping
- Virtual instrument drivers - providing digital subsystem and instrument independent test programs
- IV Curve plotting tool
- Shmoo plot tool
- Pre-defined parametric and functional tests
- Self test source code
- Predefined test examples
- Import tools supporting WGL, STIL, VCD and EVCD file formats using the optional DIOEasy-FIT option

## Automated DC Parametric Test Creation

ICEasy's library includes a full set of test capabilities for characterizing a device's input and output DC characteristics. Utilizing the TS-960's PMU per pin capabilities, users are able to quickly create test programs for the following types of tests:

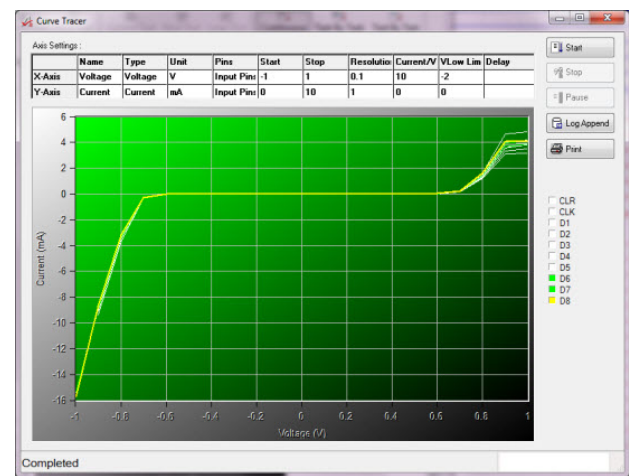
- Open and Shorts
- Input Leakage (IIL, IIH)
- Input Voltage Threshold (VIH, VIL)
- Output Short Circuit (IOSH, IOSL)
- Output Voltage Threshold (VOH, VOL)
- Power Consumption (IDD, IDDDQ)

These preconfigured tests, when combined ICEasy's Device Pin and Pin group mapping capability provides the user with a simple and streamlined method to assign tests to specific device pins as well as specifying pass / fail limits for each test, without having to do low-level instrument setup and control. The result is faster test creation and faster time to test.

## I-V Curve Tool

ICEasy's Current - Voltage (I-V) curve tool offers users the ability to graphically plot the I-V characteristics of a device's ESD diodes. This test method can provide insight into device failure mechanisms that can affect a device's I/O pins, such as electrical overstress (EOS), electrostatic discharge (ESD), bond wire problems, and packaging problems. And more recently, the use of I-V curve plots as an "impedance signature" may be useful in identifying counterfeit devices where the impedance or I-V signature of a known genuine part is compared to a suspect part.

ICEasy's I-V curve tools allows users to easily setup voltage & current ranges and step increments as well as defining by name, the specific pin (or pins) to be tested. Additionally, all I/O pins can be plotted on the same graph, providing an easy way to compare all device I-V curves. (see figure below) The plotted data can also be easily exported via the TS-960's test executive (ATEasy). The ability to easily measure I-V characteristics and plot the results is a key feature for failure analysis and design verification applications.



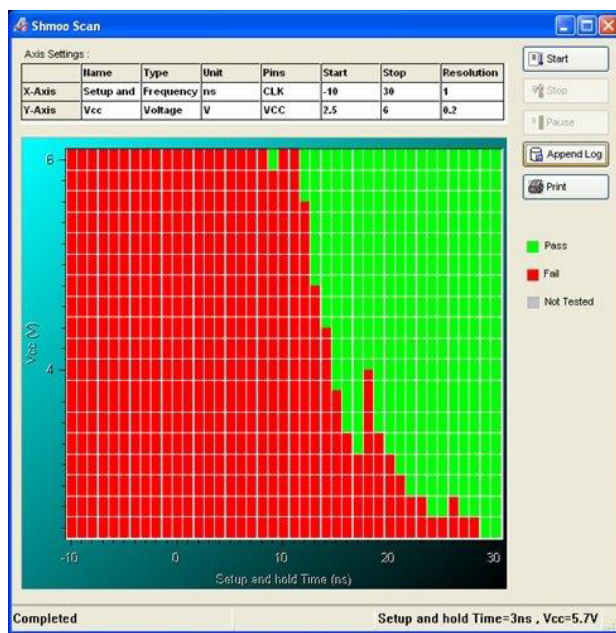
IV Curve Tracer Tool

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## Shmoo Plot Tool

ICEasy's Shmoo plot tool allows users to easily vary test parameters on both the X and Y axis without programming - allowing test engineers to visually observe the pass / fail operating ranges of the device under test. An accepted test methodology for device characterization and qualification, the addition of the Shmoo plot feature to the TS-960 platform provides users with a powerful technique for design verification and early production test qualification. Supporting both automated and interactive control, ICEasy's Shmoo tool allows users to change parameters on the fly or to control the test via the TS-960's test manager (ATEasy) as well as logging the resulting data.



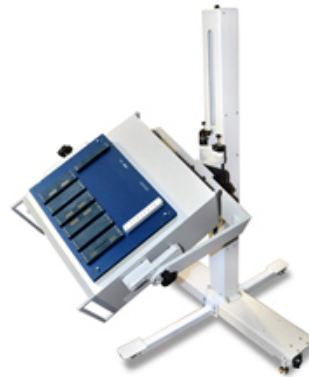
Shmoo Plot Tool

## CONFIGURATION OPTION

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TS-960 with Manipulator

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## APPLICATIONS

- Design verification for devices and modules
- Pilot production and focused production test
- Automated failure analysis and test
- Counterfeit device detection

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## SPECIFICATIONS

MAINFRAME ELECTRICAL AND MECHANICAL	
Chassis	GX7305 20 slot, high power 3U PXI chassis
Smart Chassis Features	<ul style="list-style-type: none"><li>• Temperature monitoring per slot</li><li>• System power supply voltage monitoring</li><li>• Fan monitoring and control</li><li>• PXI trigger mapping</li></ul> All features are accessible via a UI and API
PXI Triggers	Slots: 2 - 20 Number: 8 per segment Software controlled segment mapping supports: <ul style="list-style-type: none"><li>• Isolate a trigger line within a segment</li><li>• Map a trigger line left to right</li><li>• Map a trigger line right to left</li></ul>
PXI 10 MHz	Integrated 10 MHz PXI clock with an auto-detect function. Presence of an external 10 MHz clock (from external input of timing slot) will disable the internal clock. Accuracy: $\pm 100$ ppm
External 10 MHz Input	An external 10 MHz clock source (TTL level) can be provided via a rear panel BNC or via a PXI System Timing Controller
10 MHz Output	10 MHz output is available via a rear panel BNC connector, TTL compatible level.
Cooling	(4) 100 CFM fans
PXI System Power	+5 V @ 94 A +3.3 V @ 169 A +12 V @ 10 A -12 V @ 5 A
System CPU (Embedded)	Core 2 Duo, 1.5 GHz, single slot controller 4 GB of RAM
System Hard Disk	320 GB (min)
CPU Interfaces	Front panel: <ul style="list-style-type: none"><li>• (2) USB</li></ul> Rear panel: <ul style="list-style-type: none"><li>• 10 / 100-Base T, VGA, USB</li></ul>
UUT Interface	Modular, pogo-pin interface Supports up to 14 module blocks for digital, power, analog or RF applications Block connector interfaces: <ul style="list-style-type: none"><li>• 68 pin VHDC</li><li>• 78 pin D-sub</li><li>• 25 pin D-sub</li><li>• SMA</li></ul>
Input Power	120 VAC, $\pm 15\%$ 20 A (PFC) 240 VAC, $\pm 10\%$ 10 A (PFC) 47 - 440 Hz

DYNAMIC DIGITAL I/O SUBSYSTEM	
Number of Digital I/O and PMU Channels	64 (base configuration)
Maximum Configuration	512 channels
Maximum Clock Rate	125 MHz
Drive Voltage Range	-2 V to +7 V, Drive Hi & Drive Lo, maximum swing is 8 V
Memory	64 Mb per channel
Data Output Formats (per channel)	Drive Hi, Drive Lo, Hi-Z Formatted Data: No return, Return to 1, Return to 0, Return to Hi-Z, Return to complement, Surround by complement; selectable on a per channel basis
Drive Data Timing (per channel)	Data assert / de-assert based on Phases 0-7
Capture Mode Timing (assigned per channel)	Windows 0-3 Mask Capture on opening edge of Window Capture on closing edge of Window
TEST MODES	
Drive / Expect Modes	Output: Drive Hi, Drive Lo, Hi-Z Sense: Sense Lo, Sense Hi Drive / Expect: <ul style="list-style-type: none"><li>- DriveHi Expect Lo</li><li>- Drive Lo Expect Hi</li><li>- DriveHi Expect Hi</li><li>- Drive Lo Expect Lo</li></ul> Expect valid level Expect invalid level Repeat previous opcode Invert previous opcode
Record Modes	Real Time Compare: Record errors for inputs with Good 1 & Good 0 Record errors for inputs with only a Good 1 Pass/ fail condition based on expect / actual data compare Record Data: Record raw data based on NOT a Good 0 Record raw data based on a Good 1 Record raw data, Good 1 & Good 0
Error Address Record	Record address for memory errors 1K deep error memory



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TIMING	
Master Clock (PLL) Frequency Range	1 MHz (min); 125 MHz (max)
T0 Colck Period Resolution	250 ps
Accuracy	Greater of ( $\pm 1$ Hz or $\pm 0.02\%$ of programmed value) + accuracy of reference clock (PXI 10 MHz or external reference clock)
Jitter	$\pm 20$ mUI of internal clock frequency, max
Reference	PXI 10 MHz clock or XClk (external clock) input
Clocks per Vector Range	Programmable per sequence step, 1 to 256 T0 clock period must be > 50 ns if programming per seq step
Time Sets (TS0 - TS3)	8 phases, 4 windows; user assigned to DIO channels
Timing Set Sequence Control	64 Timing Sets supporting 8 Phases, 4 Windows, and 4 K sequence steps
Phase and Window Timing Resolution	1 ns, using the 125 MHz master clock
Minimum Phase / Window Pulse Width; Assert / Return Or Open / Close	4 ns
Phase / Window Reference	Phase: System (T0) or Pattern Clock (selectable per Seq Step) Window: Pattern clock only
STATUS AND CONTROL SIGNALS	
Input Trigger Functions	Pause(2), Pause - Resume (2), Jump (4), Halt, Run, and Stop
Trigger Source	Timing / Sync / Trigger Connector (J3) - (4) Aux pin electronic channels (bidirectional) - (6) LVTTTL inputs Channel Compare Event PXI Triggers 0-7 Trigger is edge or level programmable
Sync / Clock Output Functions	Sync (2), Phase, Idle Active, Sequence Active, Seq Flag (2), T0 Clk, Vector Clock, Seq Clock, Jump, Pulse Gen, Record Active, Counter Active Loop Count Done, GoSub Active, Subroutine Rtn, Return Flag, Last Sequence

Sync / Clock Outputs	Timing / Sync / Trigger Connector (J3) - (4) Aux pin electronic channels (bidirectional) - (4) LVTTTL outputs PXI Triggers 0-7 Signals are edge or level programmable
SEQUENCER	
Commands	Jump, Conditional Jump, Loop, Call Subroutine, Return, Pause, Halt
Test Inputs	External: PXI triggers, Aux I/O Internal: Data sense, Edge or level
Sequencer Memory	4096 Steps
Phase Trigger	T0_CLK or PAT_CLK
Window Trigger	PAT_CLK
Patterns per Sequence Step	1 to 64M
Loop Counter	Single loop counter Loop count range: 1 – 64K or continuous
Jump	Conditional / Unconditional
Jump Conditions	Error True, Sequence Timeout True, Signal Level (High / Low), Signal Edge (Rising / Falling)
AUXILIARY I/O CHANNELS	
Number Channels	4, can be used for timing / control functions or for static I/O
Drive Voltage Level	Drive Hi: -2 V to +7 V Drive Lo: -2 V to +7 V Maximum swing: 8 V
Drive Voltage Accuracy	$\pm 20$ mV (max)
Drive Voltage Resolution	16 bits, 250 $\mu$ V
Driver Leakage Current	$\pm 15$ nA (max)
Output Impedance	50 (typ)
Drive Current	$\pm 35$ mA (max)
Rise / Fall Times	0.5 ns typical for a 2 V pulse
Sense Voltage Range	Sense Hi: -1.75 V to +7 V Sense Lo: -1.75 V to +7 V
Sense Voltage Threshold Accuracy	$\pm 25$ mV
Sense Voltage Resolution	16 bits, 250 $\mu$ V

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Input Leakage Current	±15 nA (max)
Voltage Termination (VTT) Range	-2 V to +7 V
VTT Accuracy	±20 mV
VTT Resolution	16 bits, 250 uV
Pull-Up / Pull-Down Current Source / Sink	+24 to -20 mA, programmable on a per channel basis
Pull-Up / Pull-Down Current Source / Sink Accuracy	±124 uA
Pull-Up / Pull-Down Current Source / Sink Resolution	16 bits
Voltage Commutation (Vcomm) Range	-2V to +7V, programmable on a per channel basis Note: VTT and Vcomm share a common voltage source, only one mode supported per channel
Voltage Commutation Accuracy (typ)	±20mV
Voltage Commutation Resolution	16 bits, 250 uV
<b>DIGITAL I/O PARAMETRIC MEASUREMENT UNIT (PMU)</b>	
Number of Parametric Measurement Units	32, one per channel
Configurations	Force Voltage/Measure Current (FVMI) Force Current/Measure Voltage (FIMV) Force Voltage/Measure Voltage (FVMV) Force Current/Measure Current (FIMI)
Force Voltage Range	-1.5 V to +7 V
Force Voltage Accuracy	±20 mV
Force Voltage Resolution	16 bits
Force Current Ranges	±32 mA, ±8 mA, ±2 mA, ±512 uA, ±128 uA, ±32 uA, ±8 uA, ±2 uA FS

Force Current Accuracy; Test conditions: Vcomm @ 0 volts	±120 uA, -16 mA to +32 mA, 32 mA range ±40 uA, -6 mA to +8 mA range, 8 mA range ±5uA, 2 mA range ±2.4 uA, 512 uA range ±600 nA, 128 uA range ±160 nA, 32 uA range ±80 nA, 8 uA range ±20 nA, 2 uA range
Force Current Accuracy (typ) Vcomm: +1.75 V to +7 V	±120 uA, -16 mA to -32 mA ±40 uA, -6 mA to -8 mA
Force Current Resolution	16 bits
Current Measurement Accuracy (60 Measurements / Sec); Test conditions: Vcomm @ 0 volts	±120 uA, -16 mA to +32 mA, 32 mA range ±40 uA, -6 mA to +8 mA range, 8 mA range ±5uA, 2 mA range ±2.4 uA, 512 uA range ±600 nA, 128 uA range ±160 nA, 32 uA range ±80 nA, 8 uA range ±20 nA, 2 uA range
Current Measurement Accuracy (typ) Vcomm: +1.75 V to +7 V	±120 uA, -16 mA to -32 mA ±40 uA, -6 mA to -8 mA
Current Measurement Resolution	16 bits
Measure Voltage Range	-1.5 V to +7 V
Measure Voltage Accuracy	±2.5 mV (measurement rate < 50 measurements / sec)
High and Low PMU Commutation Voltage Range	VCLo: -2 V to +5 V VCHi: 0 V to +7 V
PMU Vcomm Accuracy	±50 mV
PMU Vcomm Resolution	16 bits
Pass / Fail PMU Voltage Comparators	Hi and Lo Voltage Threshold Range: -1.75 V to +7 V Accuracy: ±25 mV

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Pass / Fail PMU Current Comparators	Hi and Lo Current Threshold Range: -32 mA to +32 mA Accuracy @ Vcomm+ 0V: ±200 uA, -16 mA to +32 mA range ±120 uA, -6 mA to +8 mA range ±12 uA, 2 mA range ±4.8 uA, 512 uA range ±2.4 uA, 128 uA range ±200 nA, 32 uA range ±120 nA, 8 uA range ±80 nA, 2 uA range Accuracy (typ), Vcomm: +1.75 V to +7 V ±200 uA, -16 mA to -32 mA ±120 uA, -6 mA to -8 mA
<b>AUXILIARY I/O PARAMETRIC MEASUREMENT UNIT (PMU)</b>	
Number of Parametric Measurement Units	4, one per auxiliary channel
Configurations	Force Voltage/Measure Current (FVMI) Force Current/Measure Voltage (FIMV) Force Voltage/Measure Voltage (FVMV) Force Current/Measure Current (FIMI)
Force Voltage Range	-1.5 V to +7 V
Force Voltage Accuracy	±20 mV
Force Voltage Resolution	16 bits
Force Current Ranges	±32 mA, ±8 mA, ±2 mA FS
Force Current Accuracy; Test conditions: Vcomm @ 0 volts	±120 uA, -16 mA to +32 mA, 32 mA range ±40 uA, -6 mA to +8 mA range, 8 mA range ±5uA, 2 mA range
Force Current Accuracy (typ) Vcomm: +1.75 V to +7 V	±120 uA, -16 mA to -32 mA ±40 uA, -6 mA to -8 mA
Force Current Resolution	16 bits

Current Measurement Accuracy (60 Measurements / Sec); Test conditions: Vcomm @ 0 volts	±120 uA, -16 mA to +32 mA, 32 mA range ±40 uA, -6 mA to +8 mA range, 8 mA range ±5uA, 2 mA range
Current Measurement Accuracy (typ) Vcomm: +1.75 V to +7 V	±120 uA, -16 mA to -32 mA ±40 uA, -6 mA to -8 mA
Current Measurement Resolution	16 bits
Measure Voltage Range	-1.5 V to +7 V
Measure Voltage Accuracy	±3.0 mV (measurement rate < 50 measurements / sec)
High and Low PMU Commutation Voltage Range	VCLo: -2 V to +5 V VCHi: 0 V to +7 V
PMU Vcomm Accuracy	±50 mV
Vcomm Resolution	16 bits
Pass / Fail PMU Voltage Comparators	Hi and Lo Voltage Threshold Range: -1.75 V to +7 V Accuracy: ±25 mV
Pass / Fail PMU Current Comparators	Hi and Lo Current Threshold Range: -32 mA V to +32 mA Accuracy @ Vcomm= 0V: ±200 uA, -16 mA to +32 mA range ±120 uA, -6 mA to +8 mA range ±12 uA, 2 mA range Accuracy (typ), @Vcomm= +1.75 V to +7 V: ±200 uA, -16 mA to -32 mA ±120 uA, -6 mA to -8 mA



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USER POWER	
Configuration	Single channel, floating output with remote sense
Programmable Voltage Range	0 to 48 V
Output Voltage Accuracy	±0.2%, ±25 mV
Output Noise	1.5 mV <sub>RMS</sub> , 6 mV <sub>PP</sub> , full load. Measurement BW 1 MHz
Output Current	2 A @ 20 V, 0.8 A @ 48 V
Current Limit Range	0 to 2 A, 34 µA resolution
Current Readback Accuracy	±0.2% of reading, ±5 mA
Voltage Readback Accuracy	±0.1% of reading, ±10 mV
Remote Sense Voltage Difference	Up to 0.25 V for each connection
SOURCE / MEASURE UNIT (SMU) OPTION	
Configuration	4-channel, 4 quadrant operation, isolated outputs, common ground, with remote sense
Programmable Voltage Range	0 to ±20V
Output Voltage Accuracy	±0.05% of programmed value + 2 mV
Output Noise	<20 mV p-p, 20 MHz BW, full load
Output Current	±2.5 µA to ±250 mA in decade ranges, any one channel can supply up to 1A
Output Current Accuracy	±0.05% of programmed value + 0.05% of FS
Voltage Measurement Accuracy	±0.03% of programmed value + 2 mV
Current Measurement Accuracy	Ranges: 2.5 µA to 250 mA in decades & ±1 A FS Accuracy: ±0.05% of reading + 0.05% of FS range
Measurement Resolution	Programmable, 18 to 24 bits

ENVIRONMENTAL	
Operating Temperature	0 °C to +50 °C
Storage Temperature	-20 °C to +60 °C
Relative Humidity (Non-Condensing)	90%
Altitude	30,000 ft
Weight	100 lbs, core system. Does not include cart or monitor
Chassis Size	22" D x 17.5" W x 14" H

Note: Specifications are subject to change without notice

## ORDERING INFORMATION

TS-960 Series	PXI Semiconductor Test System, 64 Dynamic Digital I/O Channels with per Pin Timing & PMU, 64 Static Digital channels, 0-20V, 2A User Supply; Includes System Self Test & ATEasy Software License
OPTIONS	
TS-960-OPT64	64 Additional Dynamic Channels for use in TS-960

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